# Desert Kit Fox (Vulpes macrotis arsipus)

# **Legal Status**

**State:** None **Federal:** None

Critical Habitat: N/A Recovery Planning: N/A

**Notes:** There is disagreement about the taxonomic relationship of kit

fox (Vulpes macrotis) and swift fox (V. velox) and subspecific

designations for kit fox (e.g., Dragoo et al. 1990; Mercure et al. 1993; 57

FR 28167-28169).

# **Taxonomy**

The kit fox (*V. macrotis*) is in the family Canidae and is the smallest canid species in North America (McGrew 1979). Descriptions of its physical characteristics can be found in McGrew (1979). While the desert kit fox (V. m. arsipus) is referred to in this profile as a subspecies of the kit fox, the taxonomy of this group has been uncertain and controversial, both at the species and subspecies levels. Dragoo et al. (1990) concluded that, based on genetic data, all aridland foxes in North America pertained to a single species, the swift fox (Vulpes velox), and that morphometric data indicated that all kit foxes should be recognized as a subspecies of the swift fox. However, in a 90-day finding regarding a petition to remove the federally listed endangered San Joaquin kit fox (V. macrotis mutica) subspecies from the endangered species list based on the argument that the subspecies was not a valid taxon, the U.S. Fish and Wildlife Service (USFWS) asserted that the morphometric data presented by Dragoo et al. (1990) acknowledged the separation between the kit fox and swift fox (57 FR 28167–28169). The USFWS further cited a yet unpublished genetic study indicating that the mitochondrial DNA haplotype of the kit foxes and swift foxes was more geographically structured than that of larger canids and that gene flow between the two taxa was restricted (57 FR 28167–28169). The results of the genetic study cited in the 90-day finding were later published by Mercure et al. (1993),

which supported the conclusion that kit fox and swift fox were separate species. However, Mercure et al. (1993) also concluded, with the exception of the San Joaquin kit fox, that the genetic data did not support the other 10 subspecific designations of kit fox, including desert kit fox. Currently, no subspecies of kit fox are recognized, including desert kit fox and San Joaquin kit fox (Wilson and Reeder 2005). However, Mercure et al. (1993) acknowledged that the Colorado River may be a barrier to gene flow and that more extensive sampling would be needed to understand microgeographic barriers to gene flow such as the Colorado River.

Given that the desert kit fox subspecies is not listed as threatened or endangered, or otherwise has special state or federal status, these taxonomic issues are not relevant to its status as Covered Species under the Desert Renewable Energy Conservation Plan (DRECP).

## Distribution

#### General

For the purpose of this profile, the range of the desert kit fox (*V. m. arsipus*) as described by Hall (1981) for *V. velox arsipus* is used. The desert kit fox is a year-round resident of the southwestern deserts of California, southern Nevada, the lower elevations of western and southern Arizona, and northern Mexico. Its western boundary that separates it from the federally listed and isolated San Joaquin kit fox subspecies is the Antelope valley in the west Mojave. The Tehachapi and Southern Sierra Mountain ranges form a physical barrier between desert kit fox and San Joaquin kit fox, although Mercure et al. (1993) suggest that the lower elevation Tehachapi range may be more permeable to movement than the Southern Sierra range.

#### Distribution and Occurrences within the Plan Area

#### Historical

The desert kit fox's range historically included the entire Plan Area.

#### Recent

There is a general lack of recent distribution information for this species; however, the desert kit fox's current distribution is considered to include the entire Plan Area.

# **Natural History**

#### **Habitat Requirements**

Kit foxes generally inhabit arid regions that receive less than about 16 inches (400 millimeters) of rain annually (Tannerfeldt et al. 2003). In the Plan Area, desert kit fox primarily occurs in open desert scrub habitats on gentle slopes. Creosote bush scrub in California is the most common habitat association for desert kit fox in California (McGrew 1979). A similar association with creosote brush scrub for den sites has been documented in Arizona (Zoellick 1985; Zoellick et al. 1989). In the Great Basin Desert portion of the Plan Area, suitable habitat includes saltbush (Atriplex spp.) scrubs. Penrod et al. (2012) created a suitable habitat model for desert kit fox that covers the Plan Area and that incorporates vegetation, topography, and road density and classifies habitat as good, fair, marginal, and unsuitable. "Good" habitat includes creosote bush-white bursage desert scrub or mixed salt desert scrub on slopes less than 5% and with low road density. "Fair" habitat includes areas with slopes less than 5% and other vegetation types suitable for kit fox such as playas and washes or medium road densities. "Marginal" habitat includes areas with slopes of 5%-15% or vegetation/cover types marginal for kit fox such as dune fields. "Unsuitable" areas includes slopes greater than 15%, unsuitable vegetation/cover types such as unvegetated lands, rocklands, bedrock, cliff and outcrop, and developed and cultivated lands.

O'Farrell and Gilbertson (1986) documented desert kit foxes in the western Mojave Desert northeast of California City and south of the El Paso Mountains (Rand Open Area and Desert Tortoise Research Natural Area) using habitat dominated by *Larrea-Schismus-Erodium*, with relatively low cover of burro bush (*Ambrosia dumosa*). O'Farrell and Gilbertson (1986) characterized the study sites as disturbed by sheep grazing and off-highway vehicles (OHVs). Similarly, kit foxes in western Arizona were observed to den in creosote scrub and spend

more time in creosote scrub than expected based on its availability relative to other habitat types (Zoellick et al. 1989). About 80% of kit fox dens in the Great Basin Desert in western Utah were in sparsely vegetated shadscale flats with low vegetation of 8–10 inches, and with shadscale (*Atriplex confertifolia*) as the most common species (Egoscue 1956). Egoscue (1956) noted that while dens were located in areas with low vegetation and high visibility, prey productivity was low in these areas, requiring individuals to travel more than a mile to forage in more productive habitats. However, Arjo et al. (2003) discuss a potential tradeoff of vegetation structure around dens, with lower vegetation height providing better detection of advancing predators and higher vegetation height providing better concealment and possibly higher invertebrate prey availability. Proximity of water does not appear to be a factor in kit fox den selection (Egoscue 1956), and the species can meet it water needs through prey (McGrew 1979).

Dens are an important resource for kit fox because they provide microclimate moderation and protection from predators, and may be a limiting resource for kit fox distribution (Arjo et al. 2003). Kit foxes form monogamous pairs (at least through a breeding season) and often small family groups that occupy den complexes (Ralls and White 2003; Ralls et al. 2007). Kit foxes may dig their own dens, use dens created by other species such as badger (Taxidea taxus), or expand on burrows created by smaller species such kangaroo rats (Dipodomys spp.) and prairie dogs (Cynomys spp.) (Arjo et al. 2003; Tannerfeldt et al. 2003). Whether kit foxes dig their own dens or use dens and burrows created by other species may depend on the availability of preexisting dens/burrows, with kit foxes rarely digging dens when they do not have to (Tannerfeldt et al. 2003). Desert kit fox dens in the western Mojave in the O'Farrell and Gilbertson (1986) study tended to be on west- and northwest-facing slopes on friable soils with an absence of stones, caliche, or hardpan (O'Farrell and Gilbertson 1986). Kit foxes may also occasionally den in manmade culverts (Egoscue 1956; O'Farrell and Gilbertson 1986). Arjo et al. (2003) discuss the hypothesis that the orientation of natal den entrances may be related to protection from prevailing winds and provide other microclimatic advantages, suggesting that entrance orientation may be related to local climatic factors. Selection of den sites may also depend on the distribution of covotes (Canis latrans), which is a common natural

predator of kit foxes (e.g., Rall and White 1995; White et al. 1995; White and Garrott 1997; Kozlowski et al. 2008) and direct competitor for resources (White et al. 1995; Arjo et al. 2003, 2007; Kozlowski et al. 2008). For example, in western Utah, kit foxes may have altered their distribution and den sites to more mountainous areas and areas vegetated by non-native grasses in response to increased coyote populations in the study area since 1959 (Arjo et al. 2003) (see discussion in Ecological Relationships).

Kit fox dens typically have multiple entrances (Egoscue 1956; O'Farrell and Gilbertson 1986; Tannerfeldt et al. 2003). In the O'Farrell and Gilbertson (1986) study, dens averaged 3–5 entrances, with up to 10 entrances. Natal (pupping) dens used by desert kit foxes from January to the end of May were larger and had more entrances (5–8) than non-natal dens (3–4) used from June through December (O'Farrell and Gilbertson 1986), which also appears generally common in kit foxes (e.g., Arjo et al. 2003; Tannerfeldt et al. 2003).

Kit foxes use numerous dens, switching dens frequently, and dens tend to be clustered (Tannerfeldt et al. 2003). Clusters include several dens (in one study, up to 17) that may be more than 328 feet (100 meters) apart (Tannerfeldt et al. 2003). In San Joaquin kit fox, den switching may occur several times monthly and most often during the dispersal season, but switching is also related to age class with adults tending to use more dens than juveniles (Tannerfeldt et al. 2003). Although dens may be shared by pair-mates throughout the year, den sharing may be seasonally variable, with higher rates during December during the breeding season and lower rates in February when very young pups were present, for example (Ralls et al. 2007).

Natal dens in the western Mojave appeared to be spaced, with possible territorial exclusivity, with a minimum inter-den distance of approximately 1.25 miles (2 kilometers) (O'Farrell and Gilbertson 1986). This spacing may reflect territorial requirements and carrying capacity (O'Farrell and Gilbertson 1986). Similarly, in western Utah natal dens were at least 2 miles (3.2 kilometers) apart (Egoscue 1975). In San Joaquin kit fox, territories of adjacent social groups had only slight overlap (White and Ralls 1993).

Selection of den sites does not appear to be strongly related to nearby human activities, nor do kit foxes appear to actively avoid man-made features such as roads and structures. O'Farrell and Gilbertson (1986) found that most desert kit fox dens were within 492–656 feet (150–200 meters) of roads or trails in the western Mojave. Bjurlin et al. (2005) found that almost 10% of San Joaquin kit dens in the Bakersfield area were within 100 feet of road centerlines and that some dens used features of major roads, including culverts, embankments and underpasses, and drainage basins or canals immediately adjacent to roads.

## **Foraging Requirements**

Several studies in California, Arizona, and Utah, as summarized by Tannerfeldt et al. (2003), show that the primary food sources for kit foxes are rodents and lagomorphs, including jackrabbit (*Lepus* spp.) and cottontails (Sylvilagus spp.). Egoscue (1956) listed several prey species in the Great Basin Desert of western Utah, including blacktailed jackrabbit (Lepus californicus), kangaroo rat (Dipodomys spp.), and deer mouse (Peromyscus maniculatus), but also burrowing owl (Athene cunicularia), western meadowlark (Sturnella neglecta), horned lark (Eremophila alpetris) (notably all open ground-nesting species), side-blotched lizard (Uta stansburiana), and sand cricket (Stenopelmatus sp.). Similarly, on the Carrizo Plain in California, San Joaquin kit fox prey included kangaroo rats, pocket mice (Chaetodipus spp. and *Perognathus* spp.), deer mouse, black-tailed jackrabbit, desert cottontail (Sylvilagus audubonii), and California ground squirrel (Spermophilus beecheyi) (White and Ralls 1993). In the Plan Area, it is expected that primary prey for desert kit fox include blacktailed jackrabbit, desert cottontail, Merriam's kangaroo rat (D. merriami) (the most common and widespread kangaroo rat in the Plan Area), various pocket mice species, other rodents such as woodrats (Neotoma spp.) and California ground squirrel, and various small reptiles.

Hunting is almost strictly nocturnal, with kit foxes resting in their dens during the day (Egoscue 1956; White et al. 1995). As noted under spatial activity, individuals may move several miles daily, but it is likely that foraging distances are closely related to prey availability, which is likely variable spatially and temporally (Egoscue 1956).

## Reproduction

The desert kit fox reproductive period in the Plan Area is generally December to late May (O'Farrell and Gilbertson 1986) (see Table 1), which is consistent with other parts of the kit fox's range (e.g., Egoscue 1956; McGrew 1979). In the O'Farrell and Gilbertson (1986) study in the western Mojave, males maintained scrotal development throughout the year, but females were reproductive in December and January. Gestation is approximately 49–56 days (McGrew 1979), and females in the O'Farrell and Gilbertson (1986) study were lactating in March and April, indicating birth in February and March. Kit fox litters are 2-6 pups (Egoscue 1956; McGrew 1979; Tannerfeldt et al. 2003; USFWS 2010), and pups emerge from the natal den at about 4 weeks of age (USFWS 2010). Both adults provide care to pups. Initially males do most of the hunting while lactating females remain in the den (Egoscue 1956). In the O'Farrell and Gilbertson (1986) study, pups were absent from natal dens by the end of May. However, for San Joaquin kit fox, pups remain under the care of adults for 4 to 5 months, before beginning to disperse from their natal area as early as July and continuing through August and September (Moonjian 2007; USFWS 2010). Some offspring remain with their parents and help raise the next litter during the following year (USFWS 2010). Also in San Joaquin kit fox, yearling females may breed, with about 18% of monitored successfully reproducing (Cypher et al. 2000). Egoscue (1956) reported two lactating females in the same den on two occasions, with one instance apparently a mother and daughter.

Kit foxes generally exhibit monogamy, with pairs remaining together for several breeding seasons, and some pair bonds being permanent until the death of one of the pair (Egoscue 1956; O'Farrell and Gilbertson 1986; Ralls et al. 2007). In San Joaquin kit fox, Ralls et al. (2007) documented that 14 of 16 dissolutions of a pair were due to the death of a pair-mate, 1 was due to the male abandoning the female, and the other was due to a new male displacing the mate. Pair formation can occur throughout the year (Ralls et al. 2007).

Mortality rates in the O'Farrell and Gilbertson (1986) study were high with average observed longevity on the order of 10 months (range 8–14), although some individuals were still alive when the study was completed. Mortality resulted from several causes, including shooting,

starvation, predation (likely coyote or dog), vehicle collisions, and den collapse (see Threats and Environmental Stressors). In a study of dispersal by San Joaquin kit fox, Koopman et al. (2000) found that more than 65% of dispersing juveniles died within 10 days of leaving their natal range. The primary cause of mortality of dispersing and philopatric juveniles was predation. Kit foxes in zoos have lived 10–12 years (McGrew 1979), but such a long life span in the wild is unlikely.

Table 1. Key Seasonal Periods for Desert Kit Fox

	Jan	Feb	April	Мау	June	July	Aug	Sep	Oct	Nov	Dec
Breeding	Х	Х	Х	Х							Х
Dispersal						Х	Х	Х			

## **Spatial Activity**

Desert kit foxes are quite mobile and have relatively large home ranges. In the western Mojave, O'Farrell and Gilbertson (1986) estimated ranges of the approximately 494 acres based on radiotelemetry data. Data for other subspecies indicate at least as large to much larger home ranges, with home-range size likely related to resource availability. For San Joaquin kit fox, Koopman et al. (2001) determined a mean adult home-range size of approximately 1,072 acres and a mean pup homerange size of 325 acres on the Naval Petroleum Reserves in western Kern County (USFWS 2010). Briden et al. (1992, as cited in USFWS 2010) found that denning ranges (the area encompassing all known dens for an individual) for San Joaquin kit fox averaged approximately 1,169 acres in western Merced County. White and Ralls (1993) estimated a mean home range for San Joaquin kit fox of approximately 2,866 acres at the Carrizo Plain in 1990 and 1991, but noted these home ranges were large and likely reflected drought conditions and prey scarcity. Home ranges during this study were also relatively exclusive, with little overlap between individuals of the same sex (White and Ralls 1993). At the Camp Roberts Army National Guard Training Site in northern San Luis Obispo County, radiotelemetry documented mean home ranges for San Joaquin kit fox of approximately 5,782 acres (Root and Eliason 2001, as cited in USFWS

2010). White and Ralls (1993) suggested that large, exclusive home ranges during periods of drought may be an adaptation to episodic prey scarcity and a means to maintain their own body mass and condition.

Daily movements of desert kit foxes in western Arizona during the period of December through March averaged 8.9 miles (14.3 ±0.71 kilometers/night) for males and 7.4 miles (11.8 ±1.08 kilometers/night) for females (Zoellick et al. 1989). Males tended to move greater distances during the breeding season compared to pup rearing and pair formation periods (Zoellick et al. 1989). O'Farrell and Gilbertson (1986) did not observe young remaining in their natal territory and recorded a maximum dispersal of approximately 20 miles (32 kilometers) by a female. Egoscue (1956) reported movements up to 20 miles by juvenile kit foxes in western Utah. However, in the San Joaquin kit fox, which has been much more extensively studied than desert kit fox in the Plan Area, some offspring remain with their parents (Ralls et al 2001). Young of this subspecies may also remain their natal territory. In one study spanning 16 years, 33% of tracked juveniles dispersed from their natal territory, with significantly more males dispersing than females, and the average dispersal distance was 4.8 miles (range of 1.1 to 20 miles) (Koopman et al. 2000). Most dispersal occurred in the first year of the animal's life. Briden et al. (1992, as cited in USFWS 2010) documented dispersals of 1.2 to 12 miles. Four long-distance dispersals of between 25 and 50 miles were documented between Camp Roberts and Fort Hunter Liggett Military Reserve in Monterey County and the Carrizo Plain (California Air National Guard 2008, as cited in USFWS 2010).

Koopman et al. (2000) did not find any significant relationships between dispersal patterns in San Joaquin kit fox and demographic factors, including population density, the number or sex ratio of adults, the sex ratios of juveniles, or the proportion of new juveniles in the population. They also did not find a relationship with ecological factors, including leporid density and total prey density, small mammal abundance, or coyote abundance.

Whether the spatial activity patterns exhibited by San Joaquin kit fox are applicable to desert kit fox is unknown, but it is likely that spatial activity by desert kit fox (i.e., territory and home range use, spacing, dispersal, etc.) is also dynamic and potentially related to demographic

and environmental factors such as prey availability (see discussion in Ecological Relationships).

## **Ecological Relationships**

Fairly extensive research has been conducted on the ecological relationships of kit foxes to other species, and in particular to coyotes, which is a common predator of kit foxes (e.g., Rall and White 1995; White et al. 1995; White and Garrott 1997; Kozlowski et al. 2008) and direct competitor for prey (e.g., White et al. 1994, 1995; Arjo et al. 2007; Kozlowski et al. 2008). A brief summary of some of these studies, as they may relate to conservation of the desert kit fox in the Plan Area, is provided here.

Several studies have noted dramatic kit fox population fluctuations in relation to prey availability. For example, in San Joaquin kit fox, Cypher et al. (2000) found that high kangaroo rat densities positively influenced the growth of a kit fox population, while Moonjian (2007) found that low densities of kit foxes in the Palo Prieto area of western Kern County were associated with low densities of kangaroo rats. Local extirpations have also been linked to the previous loss of kangaroo rat populations (Cypher et al. 2000). White and Ralls (1993) found that prey scarcity related to drought reduced reproductive success in San Joaquin kit fox on the Carrizo Plain, with no reproduction by nine tracked females in 1990.

Prey selection by San Joaquin kit fox may also track availability. A 15-year study at the Naval Petroleum Reserves in western Kern County found that the dominant prey item alternated over time between kangaroo rats and leporids (Cypher et al. 2000). Similar prey studies have not been conducted for desert kit fox, but it is expected that patterns would be similar because desert rodent and lagomorph populations also vary substantially in relation to environmental conditions and possibly demographic factors. For example, Beatley (1969) found that desert rodent reproduction and population densities in southern Nevada were strongly associated with fall rain and production of winter annuals plants. Black-tailed jackrabbit densities and distribution appear to have a more complex relationship with environmental conditions because their diet shifts between seasons, locations, years, and vegetation types (Hayden 1966; Johnson and

Anderson 1984; Wansi et al. 1992). The length of the jackrabbit breeding season appears to be related to the production of herbaceous vegetation (Lechleitner 1959), and reproductive activity appears to be density-dependent, which can result in wide population fluctuations on 7–10-year cycles (French et al. 1965; Wagner and Stoddart 1972; Smith 1990).

Home-range size also appears to vary in relation to prey availability, with smaller home ranges where lagomorphs are abundant and larger home ranges when desert kit foxes have to rely on small prey such as kangaroo rats and other small rodents (Zoellick and Smith 1992).

Coyote are both predators of kit foxes and direct competitors for food, with substantial spatial, temporal, and dietary overlap (White et al. 1994, 1995; Kozlowski et al. 2008). Habitat and land use changes that attract coyotes therefore would likely have an adverse effect on desert kit foxes. Arjo et al. (2007), for example, suggest that invasion of a site in western Utah (the same site studied by Egoscue in the 1950s) by cheatgrass (Bromus tectorum), replacing native Great Basin shrub communities, and the addition of artificial water sources have altered prey abundance and attracted coyotes, to the detriment of kit foxes. Kit foxes do not require free water and are less water-limited than coyotes. The increased abundance of coyotes may have increased direct competition for food resources, with kit foxes having to focus on small rodents due to increased predation of lagomorphs by coyotes (Arjo et al. 2007). On the same Utah site, Kozlowski et al. (2008) found that kit foxes and coyotes used space within their home ranges differently, with kit foxes using areas of vegetation and ruggedness not favored by coyotes, but interactions were still common and 56% of kit fox mortalities were attributed to coyotes.

# **Population Status and Trends**

**Global:** Apparently Secure (NatureServe 2012)

State: Not ranked

Within Plan Area: Not ranked

The desert kit fox currently does not have federal or California special status, although it is protected from hunting as a fur-bearing mammal under Title 14 of the California Code of Regulations, Section 460. Population status and trends in the Plan Area are unknown, but it has

been characterized as uncommon to rare in arid regions in California (Zeiner et al. 1990). Meany et al. (2006) state that kit fox populations "plummeted" in the last half of the 19th and early 20th century due to predator and rodent controls. They report that the kit fox population in Colorado may be close to extirpation, populations in Oregon and Idaho are extremely low, and populations in the Great Basin Desert in Nevada and Utah may be in decline. The only states Meaney et al. (2006) indicate may still have stable populations are Arizona, New Mexico, and Texas.

In March 2013 The Center for Biological Diversity (CBD) submitted a petition to the California Department of Fish and Wildlife (CDFW) to list the desert kit fox as threatened under the California Endangered Species Act (Kadaba et al. 2013). The CBD cited large-scale energy development as a primary threat, in concert with OHV use, grazing, agriculture, military activities, urbanization, climate change, and increased anthropogenic disease risks (Kadaba et al. 2013). Although the species' status and trends in the Plan Area are unknown, it is reasonable to assume that the threats and stressors cited in the CBD petition have resulted in loss, fragmentation, and degradation of habitat for kit fox in the Plan Area and at least local impacts on local populations subject to these threats and stressors (see Threats and Environmental Stressors). Whether these effects, as outlined in the petition, have risen to the level of warranting a listing as threatened is yet unknown and await analysis and determination by CDFW.

#### **Threats and Environmental Stressors**

An initial cause of population declines in kit fox was predator and rodent controls in the 19th and 20th centuries (Meaney et al. 2006). Several threat factors cited by Meaney et al. (2006) for Colorado that may apply to the desert kit fox in the Plan Area are habitat degradation, loss and fragmentation from development, roads, recreation, and grazing. The expansion and increased abundance of coyotes, which is the main predator of kit foxes, is also a threat.

A potentially devastating current threat to desert kit fox is canine distemper, which was determined to be the cause of death of several kit foxes at and near a solar energy project located west of Blythe in fall 2011 (Clifford et al. 2013). The source of the distemper outbreak

is not known and may have been a domestic dog or native wildlife such as badger. This distemper outbreak is the first documented incident in wild kit foxes (Clifford et al. 2013). Subsequent trapping of 39 individuals in January 2012 at the outbreak site found that all appeared healthy, but the capture rate at the affected site was low, indicating a reduction in the local population (Clifford et al. 2013). Although the recent outbreak of canine distemper is the first documented incident in wild kit foxes, O'Farrell and Gilbertson (1986) suggested that canine distemper or some other viral or bacterial disease may have been a causal factor in the apparent starvation deaths of several desert kit fox individuals during a study conducted from 1977 to 1979 in the western Mojave, because one clinical symptom of distemper is anorexia and gradual loss of activities, which can result in starvation. O'Farrell and Gilbertson (1986) observed that the animals died over a short time period, died underground, were emaciated and had no food in their gastrointestinal tracts, showed evidence of diarrhea, and had conjunctival secretions. Unfortunately the individuals were recovered too late for histopathological diagnosis (O'Farrell and Gilbertson 1986).

In addition to habitat impacts and disease, it is expected that desert kit fox is also vulnerable to various human activities, including recreation such as OHVs. However, O'Farrell and Gilbertson (1986) found that most dens were within 490–656 feet (150–200 meters) of roads or jeep trails in the Rand Open Area in the western Mojave that was subject to unlimited OHV activity during the study from 1977 to 1979 (i.e., there was no apparent tendency to locate dens away from roads or trails). However, mortalities related to shooting, vehicle collisions, den collapse (which could result from OHV activity), and potentially canine distemper (which could be transmitted by dogs) were observed.

In more urbanized areas, vehicle collisions are a frequent source of mortality of kit foxes. Bjurlin et al. (2005) found that vehicle collisions were the primary cause of mortality of San Joaquin kit foxes in the Bakersfield area, whereas predation is the more common cause of mortality of the subspecies in natural areas (e.g., Ralls and White 1995). Bjurlin et al. (2005) found that while kit foxes frequently crossed local roads, collisions were statistically more likely to occur on arterials with higher traffic densities and speeds; about 69% of all documented strikes were on four- and six-lane arterials and about

88% of all strikes were on roads with posted speed limits of 45, 50, or 55 miles per hour (56% of strikes were on roads with a 55-mile-perhour speed limit). Bjurlin et al. (2005) also found that collisions on roads were disproportionate to males during the winter in association with territorial defense, mating, and exploratory movements. Further, even though den selection was not related to road proximity, close proximity of dens to roads increased collision risk.

Desert kit fox is also vulnerable to rodenticide poisoning (Shitoskey 1975; Meaney et al. 2006). Shitoskey (1975) demonstrated that three rodenticides—sodium monofluoroacetate (compound 1080), strychnine alkaloid, and zinc phosphate—were lethal to kit fox when administered directly. Sodium monofluoroacetate and strychnine alkaloid were also lethal when kit fox ingested kangaroo rats killed by the two rodenticides, but kit fox was able to tolerate kangaroo rats contaminated with zinc phosphate.

Military training will be an ongoing activity in the Plan Area, and noise associated with such activities, including from aircraft, may be a concern for overall stability of the desert kit fox, including potential direct effects on kit foxes and indirectly through effects on prey abundance and availability. Bowles et al. (1995) examined the effects of aircraft noise on kit fox and the desert rodent community on the Barry M. Goldwater Air Force Range in Arizona from 1991 to 1994. Monitoring on affected and control sites revealed no large differences in kit fox or rodent communities that could be attributed to aircraft noise, and observed differences between exposed and control population generally were within those expected through natural variability. Survival (as measured by "days known alive") for kit foxes on control and exposed sites were not significantly different, and the median survival days was actually higher on the exposed site at 223 days vs. 209 days for the control site. Individual weights (a measure of physical condition) and home-range sizes were also not different for the control and exposed sites. For the desert rodents, no statistical differences were found for species diversity, population densities, and weights (a measure of physical condition) between control and exposed sites. Annual rodent survival rates were higher in control sites, and recruitment was higher on exposed sites.

## **Conservation and Management Activities**

The desert kit fox is not a special-status species, nor is it covered under any existing conservation plans in or adjacent to the Plan Area. It is not explicitly addressed in federal land use planning, such as the Bureau of Land Management's (BLM's) West Mojave Plan (2005), Northern and Eastern Colorado Plan (2002a), and Northern and Eastern Mojave Plan (2002b). It is also not explicitly addressed by the National Park Service general management plans for Mojave National Preserve, Death Valley National Park, and Joshua Tree National Park.

A management and monitoring plan for desert kit fox was developed for the Genesis Solar Energy Project (AECOM 2012) where several mortalities attributed to canine distemper occurred. The plan includes several avoidance and minimization measures for the project: preconstruction surveys; den classification and excavation of inactive den complexes in the construction area to prevent reuse; monitoring of potential and known active den complexes; exclusion of kit foxes from den complexes using passive methods; and protocols for handling sick, injured, or dead kit foxes.

# **Data Characterization**

There is a lack of population and distributional information for desert kit fox in the Plan Area, including use of and movement through landscape. The local ecology of the species and the San Joaquin kit fox subspecies is well studied in some locales (e.g., western Utah, western Arizona, central California) with regard to life history traits and ecology, but only one older ecological study for the desert kit fox in the western Mojave portion of the Plan Area has been conducted (i.e., O'Farrell and Gilbertson 1986).

# **Management and Monitoring Considerations**

Because suitable den sites may be a limiting resource for desert kit fox, maintaining suitable denning habitat may be important for conservation of the species, including relatively open habitat, gentle slopes, and friable soils (O'Farrell and Gilbertson 1986; Arjo et al. 2003). Other important factors may be conversion of habitats to annual grassland that could affect prey abundance and provision of

the artificial water sources that could attract coyotes that are predators of kit foxes and direct competitors for resources. The ability of kit foxes to move through the landscape may be enhanced by providing culverts in key locations.

Understanding causes of death is also an important management and monitoring consideration for desert kit fox, especially those with potential anthropogenic causes or interactions, including diseases such as canine distemper, vehicle collisions, and coyote predation and competition.

General ecological and behavioral studies for desert kit fox are also lacking for the Plan Area. Studies of other kit fox populations across the southwest reveal substantial variability in various life history traits, including habitat selection, demographics, predator–prey relationships, and vulnerability to various threats and stressors, suggesting that effective conservation and management of the desert kit fox in the Plan Area will require additional Plan-specific information.

In addition to maintaining suitable habitat and prey availability, mobility across the landscape is an important management and monitoring consideration, especially across roads that can be significant contributors to mortality. Kit foxes are known to cross highways at grade, but their use of below-grade crossings (e.g., culverts, bridges, and underpasses) is less understood. Boarman and Sazaki (1996) incidentally documented desert kit foxes activity at culverts under State Route (SR) 58 in the Plan Area approximately 7 miles east of Kramer Junction during a study of desert tortoise (Gopherus agassizii). The study observed kit fox activity around culverts, including steel pipes that were 2.9-4.9 feet (0.9-1.5 meters) in diameter. concrete pipes 55 inches (1.4 meters) in diameter, and concrete boxes 9.8–11.8 feet (3–3.6 meters) wide by 5.9–9.8 feet (1.8–3 meters) high, but it did not provide data documenting actual crossings using the culverts or whether culverts of certain dimensions were used or avoided. Due to telemetry equipment failures and low capture rates, a recent study of below-grade crossings of the four-lane SR-58 west of Barstow by desert kit foxes by Clevenger et al. (2010) was generally unsuccessful in documenting whether kit foxes cross the highway using available corrugated metal culverts, cement box culverts, and bridge crossings. Two individuals were documented successfully crossing the

highway, but it is unknown whether the crossings were through belowgrade structures or at grade across the highway. However, Clevenger et al. (2010) did document two apparent swift fox crossings of Interstate 70 in Colorado using reinforced concrete pipe culverts and several crossings of Interstate 90 in South Dakota using culverts, including at least four two-lane and one four-lane crossing, and possibly a six-lane crossing. The dimension of the box culvert in the four-lane crossing was relatively tall and wide (84 x 84 inches) (Clevenger et al. 2010). A recent camera monitoring study for the Coachella Valley Multiple Species Habitat Conservation Plan (MSHCP) conducted at six highway underpasses in the Coachella Valley from September 2011 to April 2012 failed to detect any desert kit foxes (Murphy and Barrows 2012). However, the status and distribution of kit fox in the MSHCP plan area is unknown, so its apparent absence at the monitored underpasses is difficult to interpret.

Kit foxes in urbanized areas are known to cross roads, including sixlane arterials, but the risk of vehicle collisions is high on four- and sixlane arterials and was found to be the main cause of mortality in the Bakersfield area (Bjurlin et al. 2005). Bremner-Harrison et al. (2005) conducted a 1-year study of road culvert use in Kern County along Interstate 5, SR-14, and SR-58 and failed to document any use of culverts to cross roads. They hypothesized that kit foxes may associate the closed spaces of culverts with increased predation risk from covotes, dogs, and bobcats (Lynx rufus) that were detected in and around crossing structures. They did not study use of large structures for crossing such as bridges over larger washes, and kit fox use of large structures is unknown. The diverse desert terrain in the Plan Area includes many culvert crossings under existing roads for drainage, but use of these culverts by desert kit fox is unknown (e.g., Clevenger et al. 2010), although O'Farrell and Gilbertson (1986) documented use of a road culvert as a den.

Bremner-Harrison et al. (2005) made several recommendations regarding road crossings for kit fox that may be applicable to the Plan Area:

1. Conduct further field investigations to determine whether kit foxes are indeed avoiding structures and crossing roads, or are generally avoiding roads.

- 2. If opportunities arise, repeat this investigation in areas with median barriers to determine whether kit foxes are more likely to use crossing structures in such areas or simply abandon attempts to cross roads.
- 3. In areas where median barriers are present along highways, recommendations to reduce adverse impacts to kit foxes include:
  - a. install fencing to exclude kit foxes from the highway and direct them to crossing structures;
  - b. design crossing structures to accommodate use by the largest animal species occurring in the local ecosystem, and
  - c. place artificial dens within crossing structures and near entrances to provide escape cover for kit foxes. (Bremner-Harrison et al. 2005, p. 42)

Based on other known and likely threats and stressors to kit fox in the Plan Area, other management and monitoring considerations include:

- Developing demographic data for desert kit fox in the Plan Area, including population size and distribution
- Understanding the ecological relationships between kit foxes and coyotes in the Plan Area
- Understanding predator/prey relationships and maintaining and enhancing prey populations in areas supporting kit foxes
- Managing the use of rodenticides and other pesticides
- Managing and monitoring the incidence of diseases such as canine distemper.

# **Predicted Species Distribution in Plan Area**

This section provides the results of habitat modeling for desert kit fox, using available spatial information and occurrence information, as appropriate. For this reason, the term "modeled suitable habitat" is used in this section to distinguish modeled habitat from the habitat information provided in Habitat Requirements, which may include additional habitat and/or microhabitat factors that are important for species occupation, but for which information is not available for habitat modeling.

There are 15,686,640 acres of modeled suitable habitat for desert kit fox in the Plan Area. Appendix C includes a figure showing the modeled suitable habitat in the Plan Area.

## **Literature Cited**

- 57 FR 28167–28169. Notice of petition finding: "Endangered and Threatened Wildlife and Plants; Notice of 90-Day Findings on Petitions to List the Corral Beach Sand Dune Weevil and to Delist the San Joaquin Kit Fox." June 24, 1992.
- AECOM. 2012. American Badger and Desert Kit Fox Monitoring and Management Plan for the Genesis Solar Energy Project. Prepared for Genesis Solar LLC.
- Arjo, W.M., T.J. Bennett, and A.J. Kozlowski. 2003. "Characteristics of Current and Historical Kit Fox (*Vulpes macrotis*) Dens in the Great Basin Desert." *Canadian Journal of Zoology* 81:96–102.
- Arjo, W.M., EM. Gese, T.J. Bennett, and A.J. Kozlowski. 2007. "Changes in Kit Fox-Coyote-Prey Relationships in the Great Basin Desert, Utah." *Western North American Naturalist* 67:389–401.
- Beatley, J.C. 1969. "Dependence of Desert Rodents on Winter Annuals and Precipitation." *Ecology* 50:721–724.
- Bjurlin, C.D., B.L. Cypher, C.M. Wingert, and C.L. Van Horn Job. 2005. *Urban Roads and the Endangered San Joaquin Kit Fox.* Final Report. Prepared for the California Department of Transportation, Contract Number 65A0136.
- BLM (Bureau of Land Management). 2002a. *Proposed Northern and Eastern Colorado Desert Coordinated Management Plan (NECO) and Final Environmental Impact Statement (EIS)*. July 2002. Accessed April 2013. <a href="http://www.blm.gov/ca/news/pdfs/neco2002/Table%20of%20Contents.pdf">http://www.blm.gov/ca/news/pdfs/neco2002/Table%20of%20Contents.pdf</a>.

- BLM. 2002b. Proposed Northern and Eastern Mojave Desert Management Plan (NEMO), Amendment to the California Desert Conservation Area Plan, Final Environmental Impact Statement and Record of Decision. Accessed April 2013. <a href="http://www.blm.gov/ca/news/pdfs/nemo2002/">http://www.blm.gov/ca/news/pdfs/nemo2002/</a>.
- BLM. 2005. Final Environmental Impact Report and Statement for the West Mojave Plan, A Habitat Conservation Plan and California Desert Conservation Area Plan Amendment. Moreno Valley, California: U.S. Department of the Interior, Bureau of Land Management, California Desert District. January 2005.
- Boarman, W.I., and M. Sazaki. 1996. "Highway Mortality in Desert Tortoises and Small Vertebrates: Success or Barrier Fences and Culverts." In *Highways and Movement of Wildlife: Improving Habitat Connections and Wildlife Passageways Across Highway Corridors*, edited by G. L. Evink, D. Zeigler, P. Garrett and J. Berry, 169–173. Tallashasse, Florida: Florida Department of Transportation.
- Bowles, A.E., J. Francine, S. Wisely, J.S. Yeager, and L. McClenaghan. 1995. *Effect of Low-Altitude Aircraft Overflights on the Desert Kit Fox (Vulpes macrotis arsipus) and Its Small Prey on the Barry M. Goldwater Airforce Range, Arizona, 1991-1994.* United States Air Force Research Laboratory, AFRL-HE-WP-TR-2000-0101.
- Bremner-Harrison, S., B.L. Cypher, C.M. Fiehler, A.P. Clevenger, and D. Hacker. 2005. *Use of Highway Crossing Structures by Kit Foxes.*Prepared for the California Department of Transportation, Contract Number 43A068.
- Clevenger, A.P., A.V. Kociolek, and B.L. Cypher. 2010. *Effects of Four-Lane Highways on Desert Kit Fox and Swift Fox: Inferences for the San Joaquin Kit Fox Population*. Prepared for the California Department of Transportation, Contract Number 65A0250.

- Clifford, D.L. Woods, M.W. Gabriel, J. Rudd, E.J. Dubovi, K. Terio, F. Uzal, A. Nyaoke, A. De La Mora, S. Diab, M.T. Massar, B.L. Cypher, T.B. Darden, M. Rodriguez, and A. Gonzales. 2013. "Canine Distemper Outbreak in Free-Ranging Desert Kit Foxes Inhabiting a Solar Energy Development Zone." In proceeding of Wildlife Society 19th Annual Conference. October 13–18, 2012. Portland, Oregon.
- Cypher, B.L., G.D. Warrick, M.R.M. Otten, T.P. O'Farrell, W.H. Berry, C.E. Harris, T.T. Kato, P.M. McCue, J.H. Scrivner, and B.W. Zoellick. 2000. "Population Dynamics of San Joaquin Kit Foxes at the Naval Petroleum Reserves in California." *Wildlife Monographs* no. 145. Allen Press for the Wildlife Society.
- Dragoo, J.W., J.R. Choate, T.L. Yates, and T.P. O'Farrell. 1990. "Evolutionary and Taxonomic Relationships among North American Arid-Land Foxes." *Journal of Mammalogy* 71:318–332.
- Egoscue, H.J. 1956. "Preliminary studies of the kit fox in Utah." *Journal of Mammalogy* 37:351–357.
- Egoscue, H.J. 1975. "Population Dynamics of the Kit Fox in Western Utah." *Bulletin of the Southern California Academy of Sciences* 74:122–127.
- French, N.R., R. McBride, and J. Detmer. 1965. "Fertility and Population Density of the Black-Tailed Jackrabbit." *Journal of Wildlife Management* 29:14–26.
- Hall, E.R. 1981. *The Mammals of North America*. 2 vols. New York, New York: John Wiley and Sons Inc.
- Hayden, P. 1966. "Food Habits of Black-Tailed Jackrabbits in Southern Nevada." *Journal of Mammalogy* 47:42–46.
- Johnson, R.D., and J.E. Anderson. 1984. "Diets of Black-Tailed Jackrabbits in Relation to Population Density and Vegetation." *Journal of Wildlife Management* 37:46–47.

- Kadaba, D., I. Anderson, C. Bradley, and S. Wolf 2013. "A Petition to List the Desert Kit Fox (*Vulpes macrotis arsipus*) as Threatened under the California Endangered Species Act." Submitted to the California Department of Fish and Wildlife. March 2013.
- Koopmanm, M.E., B.L. Cypher, and J.H. Scrivner. 2000. "Dispersal Patterns of San Joaquin Kit Foxes (*Vulpes macrotis mutica*)." *Journal of Mammalogy* 81:213–222.
- Kozlowski, A.J., E.M. Gese, and W.M. Arjo. 2008. "Niche Overlap and Resource Partitioning between Sympatric Kit Foxes and Coyotes in the Great Basin Desert of Western Utah." *American Midland Naturalist* 160:191–208.
- Lechleitner, R.R. 1959. "Sex Ratio, Age Classes, and Reproduction of the Black-Tailed Jackrabbit." *Journal of Mammalogy* 40:63–81.
- McGrew, J.C. 1979. "Vulpes macrotis." Mammalian Species 123:1–6. American Society of Mammalogists.
- Meaney, C.A., M. Reed-Eckert, and G.P. Beauvais. 2006. *Kit Fox (Vulpes macrotis): A Technical Conservation Assessment.* Prepared for the USDA Forest Service, Rocky Mountain Region, Species Conservation Project.
- Mercure, A., K. Ralls, K.P. Koepfli, and R.K. Wayne. 1993. "Genetic Subdivisions among Small Canids: Mitochondrial DNA Differentiation of Swift, Kit, and Arctic Foxes." *Evolution* 47:1,313–1,328.
- Moonjian, J.M. 2007. "A Current Distribution and a Dietary Analysis of San Joaquin Kit Fox in San Luis Obispo County." Master's Thesis; California Polytechnic State University, San Luis Obispo, California.
- Murphy, M.L., and C.W. Barrows. 2012. *CVCC-FODM Coachella Valley Wildlife Corridor Analysis, Interim Progress Report.* Appendix 1, Biological Monitoring Report, to the 2011 Annual Report, Coachella Valley Multiple Species Habitat Conservation Plan/Natural Community Conservation Plan, submitted to Coachella Valley Conservation Commission (November 2012).

- NatureServe. 2012. "Vulpes macrotis." NatureServe Explorer: An Online Encyclopedia of Life. Version 7.1. February 2, 2009. Data last updated October 2012. Arlington, Virginia: NatureServe. Accessed April 2013. http://www.natureserve.org/explorer.
- O'Farrell, T.P and L. Gilbertson 1986. "Ecology of the Desert Kit Fox in the Mojave Desert." *Bulletin of the Southern California Academy of the Sciences* 85:1-15.
- Penrod, K., P. Beier, E. Garding, and C. Cabañero. 2012. *A Linkage Network for the California Deserts*. Produced for the Bureau of Land Management and the Wildlands Conservancy. Fair Oaks, California and Flagstaff, Arizona: Science and Collaboration for Connected Wildlands and Northern Arizona University.
- Ralls, K., and P.J. White. 1995. "Predation of San Joaquin Kit Foxes by Larger Canids." *Journal of Mammalogy* 76:723–729.
- Ralls, K., and P.J. White. 2003. "Diurnal Spacing Patterns in Kit Foxes, a Monogamous Canid." *The Southwestern Naturalist* 48:432–436.
- Ralls, K, B. Cypher, and LK. Spiegel. 2007. "Social Monogamy in Kit Foxes: Formation, Association, Duration, and Dissolution of Mated Pairs." *Journal of Mammalogy* 88:1,439–1,446.
- Shitoskey, F. Jr. 1975. "Primary and Secondary Hazards of Three Rodenticides to Kit Fox." *Journal of Wildlife Management* 39:416–418.
- Smith, G.W. 1990. "Home Range and Activity Patterns of Black-Tailed Jackrabbits." *Great Basin Naturalist* 50:249–256.
- Tannerfeldt, M., A. Moehrenschlager, and A. Angerbjörn. 2003. "Den Ecology of the Swift, Kit, and Artic Foxes: A Review." In *Ecology and Conservation of Swift Foxes in a Changing World*. Edited by M.A. Sovada and L.N. Carbyn, 167–181. Regina, Sask.: Canadian Plains Research Center.

- USFWS (U.S. Fish and Wildlife Service). 2010. San Joaquin Kit Fox (Vulpes macrotis mutica), 5-Year Review: Summary and Evaluation. Sacramento, California: Sacramento Fish and Wildlife Office. February 2010.
- Wagner, F.H., and L.C. Stoddart. 1972. "Influence of Coyote Predation on Black-Tailed Jackrabbit Populations in Utah." *Journal of Wildlife Management* 36:329–342.
- Wansi, T., R.D. Pieper, R.F. Beck, and L.W. Murray. 1992. "Botanical Content of Black-Tailed Jackrabbit Diets on Semidesert Rangeland." *Great Basin Naturalist* 52:300–308.
- White, P.J., and R.A. Garrott. 1997. "Factors Regulating Kit Fox Populations." *Canadian Journal of Zoology* 77:486–493.
- White, P.J., and K. Ralls. 1993. "Reproduction and Spacing Patterns of Kit Foxes Relative to Changing Prey Availability." *Journal of Wildlife Management* 57:861–867.
- White, P.J., K. Ralls, and R.A. Garrott. 1994. "Coyote–Kit Fox Interactions as Revealed by Telemetry." Abstract. *Canadian Journal of Zoology* 72:1,831–1,836.
- White, P.J., K. Ralls, and C.A. Vanderbilt White. 1995. "Overlap in Habitat and Food Use between Coyotes and San Joaquin Kit Foxes." *Southwestern Naturalist* 40:342–349.
- Wilson, D.E., and D.M. Reeder, eds. 2005. *Mammal Species of the World: A Taxonomic and Geographic Reference*. 3rd ed. Baltimore, Maryland: Johns Hopkins University Press.
- Zeiner, D.C., W.F. Laudenslayer Jr., K.E. Mayer, and M. White, eds. 1990. *California's Wildlife: Volume III, Mammals*. Sacramento, California: CDFG.
- Zoellick, B.W. 1985. "Kit Fox Movements and Home Range Use in Western Arizona." Master's Thesis, University of Arizona.

#### DRAFT August 2014

## **Desert Kit Fox (Vulpes macrotis arsipus)**

Zoellick, B.W., and N.S. Smith 1992. "Size and Spatial Organization of Home Ranges of Kit Foxes in Arizona." *Journal of Mammalogy* 73:83–88.

Zoellick, B.W., N.S. Smith, and R.S. Henry. 1989. "Movements and Habitat Use of Desert Kit Foxes in Western Arizona." *Journal of Wildlife Management* 53:955–961.

#### DRAFT August 2014



**Desert Kit Fox (Vulpes macrotis arsipus)** 

INTENTIONALLY LEFT BLANK

